PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 22 March 2001 (22.03.01)	
International application No. PCT/CA00/00808	**Applicant's or agent's file reference** GP/10875.100
International filing date (day/month/year) 07 July 2000 (07.07.00)	**Priority date** (day/month/year) 07 July 1999 (07.07.99)
Applicant SINDERBY, Christer et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

06 February 2001 (06.02.01)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Claudio Borton
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

Form PCT/IB/331 (July 1992)

CA0000808

PATENT COOPERATION TREATY

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

DUBUC, Jean H. et al
GOUDREAU GAGE DUBUC
The Stock Exchange Tower
800 Place Victoria, Suite 3400
P.O.Box 242
Montréal, Quebec H4Z 1E9
CANADA

27 JUIL 2001

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of mailing *(day/month/year)*	24.07.2001
Applicant's or agent's file reference: GP/10875.100	**REPLY DUE** **within 1 month(s)** from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA00/00808	07/07/2000	07/07/1999

International Patent Classification (IPC) or both national classification and IPC

A61B5/0488

Applicant

UNIVERSITE DE MONTREAL et al

1. This written opinion is the **first** drawn up by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

I	☒	Basis of the opinion
II	☐	Priority
III	☒	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☐	Lack of unity of invention
V	☐	Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	☐	Certain document cited
VII	☐	Certain defects in the international application
VIII	☐	Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis.
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 07/11/2001.

Name and mailing address of the international preliminary examining authority:

European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer / Examiner
Hooper, M

Formalities officer (incl. extension of time limits)
Marra, E
Telephone No. +49 89 2399 7235

I. Basis of the opinion

1. With regard to the **elements** of the international application (Replacement *sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed"*):

Description, pages:

1-23 as originally filed

Claims, No.:

1-28 as originally filed

Drawings, sheets:

1/11-11/11 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been and will not be examined in respect of:

   ☐ the entire international application,

   ☒ claims Nos. 1-14,

because:

   ☒ the said international application, or the said claims Nos. 1-14 relate to the following subject matter which does not require an international preliminary examination (*specify*):
   see separate sheet

   ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

   ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

   ☐ no international search report has been established for the said claims Nos. .

2. A written opinion cannot be drawn due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

   ☐ the written form has not been furnished or does not comply with the standard.

   ☐ the computer readable form has not been furnished or does not comply with the standard.

Re Item III

The subject-matter of claim 1 is concerned with a method of producing a higher quality electromyographic signal, and it contains the step of "sensing through an array of electrodes a plurality of EMG signals [...]". In view of the description it is seen that this step includes the insertion of a tube into the oesophagus, which is considered to be a surgical step, as it can only be performed by a skilled surgeon. Therefore the method is deemed to be a method for the treatment by surgery, and no preliminary examination needs to be done for such a method, Rule 67.1(iv) PCT. As claims 2-14 are directly or indirectly dependent on claim 1 the same applies for the subject-matter of these claims.

Further points to note

1. It is pointed out to the applicant that the system as defined in claims 15-28 is considered to be new and inventive in view of the available prior art.

2. The applicant is requested to file amendments by way of replacement pages in the manner stipulated by Rule 66.8(a) PCT. In particular, fair copies of the amendments should be filed preferably in triplicate.

   Moreover, the applicant's attention is drawn to the fact that, as a consequence of Rule 66.8(a) PCT the examiner is not permitted to carry out any amendments under the PCT procedure, however minor these may be.

3. On filing a new set of claims the applicant is requested to bring the description into conformity with the new set of claims, as required by Rule 5.1(a)(iii) PCT.

4. Any information the applicant may wish to submit concerning the subject-matter of the invention, for example further details of its advantages or of the problem it solves, and for which there is no basis in the application as filed, should be confined to the letter of reply rather than be incorporated into the application, Article 34(2)(b) PCT.

PATENT COOPERATION TREATY

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

DUBUC, Jean H. et al
GOUDREAU GAGE DUBUC
The Stock Exchange Tower
800 Place Victoria, Suite 3400
P.O.Box 242
Montréal, Quebec H4Z 1E9
CANADA

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of mailing *(day/month/year)*	09.10.2001
Applicant's or agent's file reference: GP/10875.100	**REPLY DUE** **within 0 month(s) and 7 days** from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA00/00808	07/07/2000	07/07/1999

International Patent Classification (IPC) or both national classification and IPC

A61B5/0488

Applicant

UNIVERSITE DE MONTREAL et al

1. This written opinion is the **second** drawn up by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

I	☒	Basis of the opinion
II	☐	Priority
III	☒	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☐	Lack of unity of invention
V	☒	Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	☐	Certain document cited
VII	☐	Certain defects in the international application
VIII	☐	Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4. For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis. For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 07/11/2001.

Name and mailing address of the international preliminary examining authority:

European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer / Examiner

Hooper, M

Formalities officer (incl. extension of time limits)

Edel, M

Telephone No. +49 89 2399 2426

I. Basis of the opinion

1. With regard to the **elements** of the international application (Replacement *sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed"*):

Description, pages:

1-23 as originally filed

Claims, No.:

1-28 as originally filed

Drawings, sheets:

1/11-11/11 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been and will not be examined in respect of:

☐ the entire international application,

☒ claims Nos. 1-14, 16-28,

because:

☒ the said international application, or the said claims Nos. 1-14 relate to the following subject matter which does not require an international preliminary examination (*specify*):
see separate sheet

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 16-28 are so unclear that no meaningful opinion could be formed (*specify*):
see separate sheet

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A written opinion cannot be drawn due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	
Inventive step (IS)	Claims	15

Industrial applicability (IA) Claims

2. Citations and explanations
see separate sheet

Re Item III

1. The subject-matter of claim 1 is concerned with a method of producing a higher quality electromyographic signal, and it contains the step of "sensing through an array of electrodes a plurality of EMG signals [...]". In view of the description it is seen that this step includes the insertion of a tube into the oesophagus, which is considered to be a surgical step, as it can only be performed by a skilled surgeon. Therefore the method is deemed to be a method for the treatment by surgery, and no preliminary examination needs to be done for such a method, Rule 67.1(iv) PCT. As claims 2-14 are directly or indirectly dependent on claim 1 the same applies for the subject-matter of these claims.

2. The subject-matter of claim 15 is not inventive, see "Re Item V" below. As claims 16-23 are all dependent on claim 15, it is no longer clear what **the** invention according to Article 33(1) PCT is supposed to be. It is therefore not possible to establish an opinion regarding novelty and inventive step of these claims and claims dependent thereon.

Re Item V

1. Reference is made to the following documents.
   D1: WO-A-98/48877
   D2: HARALD REUCHER ET AL: 'Spatial filtering of noninvasive emg: part I - introduction to measuring technique and applications' IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, vol. BME-34, no. 2, 1 February 1987 (1987-02-01), pages 98-105, New York, US

2. The subject-matter of claim 15 does not appear to contain an inventive step, Article 33(3) PCT. The reasons are as follows.

2.1. Document D1 shows (see D1, page 13, line 19 - page 16, line 24) a system for producing a higher quality electromyographic signal describing myoelectrical activity of an electrically active region of a subject's muscle, comprising: an array of electrodes (12) for sensing a plurality of EMG signals representative of the myoelectrical activity of the electrically active region of the subject's muscle; and a combiner of the weighted signals (the subtractor), the combined weighted signals constituting the higher quality electromyographic signal.

2.2. Document D1 does not show a weighting filter containing correction features for the relative locations of the electrically active region and the electrodes. The subject-matter of claim 15 is therefore novel, Article 33(2) PCT.

2.3. However, such a weighting filter appears to be commonplace, as implied in document D2, in the paragraph entitled "spatial filtering technique" bridging pages 99 and 100. There it appears the signal is weighted according to the relative location of the electrically active region and the electrodes, and this appears to be common standard practice. Hence to include such a filtering into the device as known from D1 does not contain an inventive step, Article 33(3) PCT.

Further points to note

1. The applicant is requested to file amendments by way of replacement pages in the manner stipulated by Rule 66.8(a) PCT. In particular, fair copies of the amendments should be filed preferably in triplicate.

   Moreover, the applicant's attention is drawn to the fact that, as a consequence of Rule 66.8(a) PCT the examiner is not permitted to carry out any amendments under the PCT procedure, however minor these may be.

2. On filing a new set of claims the applicant is requested to bring the description into conformity with the new set of claims, as required by Rule 5.1(a)(iii) PCT.

3. Any information the applicant may wish to submit concerning the subject-matter of the invention, for example further details of its advantages or of the problem it solves, and for which there is no basis in the application as filed, should be confined to the letter of reply rather than be incorporated into the application, Article 34(2)(b) PCT.

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

DUBUC, Jean H. et al
GOUDREAU GAGE DUBUC
The Stock Exchange Tower
800 Place Victoria, Suite 3400
P.O.Box 242
Montréal, Quebec H4Z 1E9
CANADA

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing *(day/month/year)*	23.10.2001
Applicant's or agent's file reference	**IMPORTANT NOTIFICATION**
GP/10875.100	

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA00/00808	07/07/2000	07/07/1999

Applicant
UNIVERSITE DE MONTREAL et al

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/

European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer

Edel, M

Tel.+49 89 2399-2426

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
GP/10875.100		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/CA00/00808	07/07/2000	07/07/1999
International Patent Classification (IPC) or national classification and IPC A61B5/0488		
Applicant UNIVERSITE DE MONTREAL et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
06/02/2001	23.10.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Hooper, M Telephone No. +49 89 2399 7438

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/CA00/00808

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-23 as originally filed

Claims, No.:

1-28 as originally filed

Drawings, sheets:

1/11-11/11 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 1-14, 16-28.

because:

☒ the said international application, or the said claims Nos. 1-14 relate to the following subject matter which does not require an international preliminary examination (*specify*):
see separate sheet

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 16, 18 are so unclear that no meaningful opinion could be formed (*specify*):
see separate sheet

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N) Yes: Claims 15

	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	15
Industrial applicability (IA)	Yes:	Claims	15
	No:	Claims	

2. Citations and explanations
see separate sheet

Re Item III

1. The subject-matter of claim 1 is concerned with a method of producing a higher quality electromyographic signal, and it contains the step of "sensing through an array of electrodes a plurality of EMG signals [...]". In view of the description it is seen that this step includes the insertion of a tube into the oesophagus, which is considered to be a surgical step, as it can only be performed by a skilled surgeon. Therefore the method is deemed to be a method for the treatment by surgery, and no preliminary examination needs to be done for such a method, Rule 67.1(iv) PCT. As claims 2-14 are directly or indirectly dependent on claim 1 the same applies for the subject-matter of these claims.

2. The subject-matter of claim 15 is not inventive, see "Re Item V" below. As claims 16-23 are all dependent on claim 15, it is no longer clear what **the** invention according to Article 33(1) PCT is supposed to be. It is therefore not possible to establish an opinion regarding novelty and inventive step of these claims and claims dependent thereon.

Re Item V

1. Reference is made to the following documents.
   D1: WO-A-98/48877
   D2: HARALD REUCHER *et al.*: 'Spatial filtering of noninvasive emg: part I - introduction to measuring technique and applications' IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, vol. BME-34, no. 2, 1 February 1987 (1987-02-01), pages 98-105, New York, US

2. The subject-matter of claim 15 does not appear to contain an inventive step, Article 33(3) PCT. The reasons are as follows.

2.1. Document D1 shows (see D1, page 13, line 19 - page 16, line 24) a system for producing a higher quality electromyographic signal describing myoelectrical activity of an electrically active region of a subject's muscle, comprising: an array of electrodes (12) for sensing a plurality of EMG signals representative of the myoelectrical activity of the electrically active region of the subject's muscle; and a combiner of the weighted signals (the subtractor), the combined weighted signals constituting the higher quality electromyographic signal.

2.2. Document D1 does not show a weighting filter containing correction features for the relative locations of the electrically active region and the electrodes. The subject-matter of claim 15 is therefore novel, Article 33(2) PCT.

2.3. However, such a weighting filter appears to be commonplace, as implied in document D2, in the paragraph entitled "spatial filtering technique" bridging pages 99 and 100. There it appears the signal is weighted according to the relative location of the electrically active region and the electrodes, and this appears to be common standard practice. Hence to include such a filtering into the device as known from D1 does not contain an inventive step, Article 33(3) PCT.

The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are with the one chosen by the applicant. The name or two-letter code of that Authority may be indicated by the applicant on the line

IPEA/ _____

PCT

CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:
The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated).

For International Preliminary Examining Authority use only

Identification of IPEA	Date of receipt of DEMAND

Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION		Applicant's or agent's file reference GP/10875.100
International application No. PCT/CA00/00808	International filing date *(day/month/year)* 07 July 2000 (07/07/00)	(Earliest) Priority date *(day/month/year)* 07 July 1999 (07/07/99)

Title of invention
METHOD AND SYSTEM FOR PRODUCING A HIGHER QUALITY ELECTROMYOGRAPHIC SIGNAL FROM AN ELECTRODE ARRAY

Box No. II APPLICANT(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*	Telephone No.: (514) 343-6786
UNIVERSITÉ DE MONTRÉAL P. O. Box 6128, Station A Montreal, Quebec H3C 3J7 CANADA	Facsimile No.: (514) 343-2326
	Teleprinter No.:

State *(that is, country)* of nationality:	State *(that is, country)* of residence:
CA	CA

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

SINDERBY, Christer
12750, 27th Avenue
Montreal, Quebec
H1E 1Z9
CANADA

State *(that is, country)* of nationality:	State *(that is, country)* of residence:
CA	CA

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

BECK, Jennifer
12750, 27th Avenue
Montreal, Quebec
H1E 1Z9
CANADA

State *(that is, country)* of nationality:	State *(that is, country)* of residence:
CA	CA

☒ Further applicants are indicated on a continuation sheet.

Sheet No. 2.

International application No.
PCT/CA00/00808

Continuation of Box No. II APPLICANT(S)

If none of the following sub-boxes is used, this sheet is not to be included in the demand.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

LINDSTROM, Lars
Lekevallsgatan 46
S431 69 Moindal
SWEDEN

State *(that is, country)* of nationality:	State *(that is, country)* of residence:
SE	SE

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State *(that is, country)* of nationality:	State *(that is, country)* of residence:

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State *(that is, country)* of nationality:	State *(that is, country)* of residence:

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State *(that is, country)* of nationality:	State *(that is, country)* of residence:

☐ Further applicants are indicated on another continuation sheet.

International application No.
PCT/CA00/00808

Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The following person is ☒ agent ☐ common representative

and ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination.

☐ is hereby appointed and any earlier appointment of (an) agent(s) /common representative is hereby revoked.

☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.

Name and address: *(Family name followed by given name; for a legal entity, full official The address must include postal code and name of country.)*

DUBUC, J. H..;LECLERC, A. M.;PRINCE, G.;LUPIEN, M.;BRITT, K.
GOUDREAU GAGE DUBUC
The Stock Exchange Tower
800 Place Victoria, Suite 3400
P.O. Box 242
Montreal, Quebec
H4Z 1E9, CANADA

Telephone No.: (514) 397-7604

Facsimile No.: (514) 397-4382

Teleprinter No.:

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION

Statement concerning amendments:*

1. The applicant wishes the international preliminary examination **to start on the basis of:**

☒ the international application as originally filed.

the description ☐ as originally filed
☐ as amended under Article 34

the claims ☐ as originally filed
☐ as amended under Article 19 (together with any accompanying statement)
☐ as amended under Article 34

the drawings ☐ as originally filed
☐ as amended under Article 34

2. ☐ The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.

3. ☐ The applicant wishes the start of the international preliminary examination **to be postponed** until the expiration of 20 months from the priority date unless the International Preliminary Examing Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired.)*

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Language for the purposes of international preliminary examination: ENGLISH

☒ which is the language in which the international application was filed.
☐ which is the language of a translation furnished for the purposes of international search.
☐ which is the language of publication of the international application.
☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination.

Box No. V ELECTION OF STATES

The applicant hereby **elects all eligible States** *(that is, all States which have been designated and which are bound by Chapter II of the PCT)*

excluding the following States which the applicant wishes **not to elect:**

Sheet No. 4.

national application No.
PCT/CA00/00808

Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:			For International Preliminary Examining Authority use only: received	not received
1. translation of international application	:	sheets	☐	☐
2. amendments under Article 34	:	sheets	☐	☐
3. copy (or where required, translation) of amendments under Article 19	:	sheets	☐	☐
4. copy (or, where required, translation) of statement under Article 19	:	sheets	☐	☐
5. letter	:	sheets	☐	☐
6. other *(specify)*	:	sheets	☐	☐

The demand is also accompanied by the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ nucleotide and or amino acid sequence listing in computer readable form
6. ☐ other *(specify)*:

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).

GOIUDREAU GAGE DUBUC

GAÉTAN PRINCE

For International Preliminary Examining Authority use only

1. Date of actual receipt of DEMAND:
2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):
3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply. ☐ The applicant has been informed accordingly.
4. ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5.
5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

For International Bureau use only

Demand received from IPEA on:

CHAPTER II

PCT

FEE CALCULATION SHEET

Annex to the Demand for international preliminary examination

International application No.	PCT/CA00/00808
Applicant's or agent's file reference	GP/10875.100

For International Preliminary Examining Authority use only

Date stamp of the IPEA

Applicant

UNIVERSITÉ DE MONTRÉAL, ET AL

Calculation of prescribed fees

1. Preliminary examination fee	2,998.29	P
2. Handling fee *(Applicants from certain States are entitled to a reduction of 75% of the handling fee. Where the applicant is (or all applicants are) so entitled, the amount to be entered at H is 25% of the handling fee.)*	287.51	H
3. Total of prescribed fees Add the amounts entered at P and H and enter total in the TOTAL box	3,285.80	TOTAL

Mode of Payment

- ☐ authorization to charge deposit account with the IPEA (see below)
- ☐ cheque
- ☐ postal money order
- ☐ bank draft
- ☐ cash
- ☐ revenue stamps
- ☐ coupons
- ☐ other *(specify)*:

Deposit Account Authorization *(this mode of payment may not be available at all IPEAs)*

The IPEA/ _____ ☐ is hereby authorized to charge the total fees indicated above to my deposit account.

☐ *(this check-box may be marked only if the conditions for deposit accounts of the IPEA so permit)* is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.

Deposit Account Number _____ Date *(day/month/year)* _____ Signature _____

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* GP/10875.100

Box No. I TITLE OF INVENTION

METHOD AND SYSTEM FOR PRODUCING A HIGHER QUALITY ELECTROMYOGRAPHIC SIGNAL FROM AN ELECTRODE ARRAY

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

UNIVERSITÉ DE MONTRÉAL
P.O.Box 6128, Station A
Montreal, Quebec
H3C 3J7
CANADA

☐ This person is also inventor.

Telephone No.
(514) 343-6786

Facsimile No.
(514) 343-2326

Teleprinter No.

State *(that is, country)* of nationality: CA

State *(that is, country)* of residence: CA

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

SINDERBY, Christer
12750, 27th Avenue
Montreal, Quebec
H1E 1Z9
CANADA

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: CA

State *(that is, country)* of residence: CA

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

DUBUC, Jean H.; LECLERC, Alain M; PRINCE, Gaétan; LUPIEN, Marc;BRITT, K.
GOUDREAU GAGE DUBUC
The Stock Exchange Tower
800 Place Victoria, Suite 3400
P.O. Box 242
Montreal, Quebec, H4Z 1E9, CANADA

Telephone No.
(514) 397-7604

Facsimile No.
(514) 397-4382

Teleprinter No.

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Continuation of Box No. III FURTHER APPLICANTS AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet is not to be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

BECK, Jennifer
12750, 27th Avenue
Montreal, Quebec
H1E 1Z9
CANADA

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: CA

State *(that is, country)* of residence: CA

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

LINDSTROM, Lars
Lekevallsgatan 46
S431 69 Molndal
SWEDEN

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: SE

State *(that is, country)* of residence: SE

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

☒ **AP** **ARIPO Patent:** GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, MZ Mozambique, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT

☒ **EA** **Eurasian Patent:** AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT

☒ **EP** **European Patent:** AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT

☒ **OA** **OAPI Patent:** BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

☒ **AE** United Arab Emirates
☒ **AG** Antigua and Barbuda
☒ **AL** Albania .....
☒ **AM** Armenia .....
☒ **AT** Austria .....
☒ **AU** Australia .....
☒ **AZ** Azerbaijan
☒ **BA** Bosnia and Herzegovina .....
☒ **BB** Barbados
☒ **BG** Bulgaria .....
☒ **BR** Brazil .....
☒ **BY** Belarus .....
☒ **BZ** Belize
☒ **CA** Canada
☒ **CH and LI** Switzerland and Liechtenstein
☒ **CN** China .....
☒ **CR** Costa Rica .....
☒ **CU** Cuba .....
☒ **CZ** Czech Republic .....
☒ **DE** Germany .....
☒ **DK** Denmark .....
☒ **DM** Dominica
☒ **DZ** Algeria .....
☒ **EE** Estonia .....
☒ **ES** Spain .....
☒ **FI** Finland .....
☒ **GB** United Kingdom
☒ **GD** Grenada
☒ **GE** Georgia .....
☒ **GH** Ghana .....
☒ **GM** Gambia
☒ **HR** Croatia .....
☒ **HU** Hungary .....
☒ **ID** Indonesia
☒ **IL** Israel .....
☒ **IN** India .....
☒ **IS** Iceland
☒ **JP** Japan .....
☒ **KE** Kenya .....
☒ **KG** Kyrgyzstan .....
☒ **KP** Democratic People's Republic of Korea .....
☒ **KR** Republic of Korea .....
☒ **KZ** Kazakhstan .....
☒ **LC** Saint Lucia
☒ **LK** Sri Lanka
☒ **LR** Liberia
☒ **LS** Lesotho .....
☒ **LT** Lithuania
☒ **LU** Luxembourg
☒ **LV** Latvia
☒ **MA** Morocco .....
☒ **MD** Republic of Moldova .....
☒ **MG** Madagascar .....
☒ **MK** The former Yugoslav Republic of Macedonia .....
☒ **MN** Mongolia
☒ **MW** Malawi .....
☒ **MX** Mexico .....
☒ **MZ** Mozambique
☒ **NO** Norway
☒ **NZ** New Zealand .....
☒ **PL** Poland .....
☒ **PT** Portugal .....
☒ **RO** Romania
☒ **RU** Russian Federation .....
☒ **SD** Sudan
☒ **SE** Sweden
☒ **SG** Singapore
☒ **SI** Slovenia .....
☒ **SK** Slovakia .....
☒ **SL** Sierra Leone .....
☒ **TJ** Tajikistan .....
☒ **TM** Turkmenistan .....
☒ **TR** Turkey .....
☒ **TT** Trinidad and Tobago .....
☒ **TZ** United Republic of Tanzania
☒ **UA** Ukraine .....
☒ **UG** Uganda .....
☒ **US** United States of America .....
☒ **UZ** Uzbekistan .....
☒ **VN** Viet Nam .....
☒ **YU** Yugoslavia .....
☒ **ZA** South Africa .....
☒ **ZW** Zimbabwe .....

Check-box reserved for designating States which have become party to the PCT after issuance of this sheet:

☐ .....

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)*

Box No. VI PRIORITY CLAIM ☐ Further priority claim indicated in the Supplemental Box.

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: receiving Office
item (1) 7 July 1999 (07/07/99)	2,276,962	CA		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s): (1)

** Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*

ISA/ EPO

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*

Date *(day/month/year)* Number Country (or regional Office)

Box No. VIII CHECK LIST: LANGUAGE OF FILING

This international application contains the following **number of sheets:**

request	:	4
description (excluding sequence listing part)	:	24
claims	:	9
abstract	:	11
drawings	:	11
sequence listing part of description	:	
Total number of sheets	:	59

This international application is **accompanied** by the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☐ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☒ priority document(s) identified in Box No. VI as items(s): TO FOLLOW
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☐ other *(specify):*

Figure of the drawings which should accompany the abstract: 1

Language of filing of the international application: ENGLISH

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

GOUDREAU GAGE DUBUC

GAÉTAN PRINCE

For receiving Office use only

1. Date of actual receipt of the purported international application:
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA/
6. ☐ Transmittal of search copy delayed until search fee is paid

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

This sheet is not part and does not count as a sheet of the international application.

PCT

FEE CALCULATION SHEET

Annex to the Request

For receiving Office use only

International application No.

Date stamp of the receiving Office

Applicant's or agent's file reference: GP/10875.100

Applicant: UNIVERSITÉ DE MONTRÉAL, et al

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE ..... 200.00 T

2. SEARCH FEE ..... 1,353.00 S

International search to be carried out by EPO

(If two or more International Searching Authorities are competent in relation to the international application, indicate the name of the Authority which is chosen to carry out the international search.)

3. INTERNATIONAL FEE

Basic Fee

The international application contains 59 sheets.

first 30 sheets ..... 630.00 b_1

29 remaining sheets x $15.00 additional amount = 435.00 b_2

Add amounts entered at b_1 and b_2 and enter total at B .. 1,065.00 B

Designation Fees

The international application contains 87 designations.

8 number of designation fees payable *(maximum 11)* x 136.00 amount of designation fee = 1,088.00 D

Add amounts entered at B and D and enter total at I ..... 2,153.00 I

(Applicants from certain States are entitled to a reduction of 75% of the international fee. Where the applicant is (or all applicants are) so entitled, the total to be entered at I is 25% of the sum of the amounts entered at B and

4. FEE FOR PRIORITY DOCUMENT *(if applicable)* ..... P

5. TOTAL FEES PAYABLE

Add amounts entered at T, S, I and P, and enter total in the TOTAL box: 3,706.00 TOTAL

☐ The designation fees are not paid at this time.

MODE OF PAYMENT

- ☒ authorization to charge deposit account (see below)
- ☐ bank draft
- ☐ coupons
- ☐ cheque
- ☐ cash
- ☐ other *(specify)*:
- ☐ postal money order
- ☐ revenue stamps

DEPOSIT ACCOUNT AUTHORIZATION *(this mode of payment may not be available at all receiving Offices)*

The RO/ CA

- ☒ is hereby authorized to charge the total fees indicated above to my deposit account.
- ☒ is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.
- ☐ is hereby authorized to charge the fee for preparation and transmittal of the priority document to the International Bureau of WIPO to my deposit account.

600000102	07/07/2000	
Deposit Account Number	Date *(day/month/year)*	Signature

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
GP/10875.100		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/CA 00/ 00808	07/07/2000	07/07/1999
Applicant		
UNIVERSITE DE MONTREAL		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/[redacted]00/00808

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B5/0488 A61B5/0492

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61B G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, INSPEC, BIOSIS, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	TADASHI MASUDA ET AL: "the position of innervation zones in the biceps brachii investigated by surface electromyography" IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, vol. BME-32, no. 1, 1 January 1985 (1985-01-01), pages 36-42, XP002153958 New York, US page 36, left-hand column, line 1 -page 40, right-hand column, line 28; tables 1-6 ---	1,2,4-8, 10,15, 16, 18-22,24
Y	WO 98 48877 A (GRASSINO ALEJANDRO ;SINDERBY CHRISTER (SE); FRIBERG SVEN (SE); LIN) 5 November 1998 (1998-11-05) page 13, line 19 -page 19, line 14; tables 1-7 --- -/--	1,2,4-8, 10,15, 16, 18-22,24

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 November 2000	12/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Weihs, J

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/[redacted]00/00808

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 671 752 A (SINDERBY CHRISTER ET AL) 30 September 1997 (1997-09-30) column 2, line 61 -column 5, line 50 ---	1,2,4, 15,16,18
A	HARALD REUCHER ET AL: "spatial filtering of noninvasive emg: part I - introduction to measuring technique and applications" IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, vol. BME-34, no. 2, 1 February 1987 (1987-02-01), pages 98-105, XP002153959 New York, US page 98, column 1, line 1 -page 104, left-hand column, line 2; tables 1-6 -----	1,15

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INTERNATIONAL SEARCH REPORT

Information [redacted]atent family members

Internati[redacted] Application No
PCT/[redacted]00/00808

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 9848877	A	05-11-1998	US	5820560 A	13-10-1998
			AU	3534497 A	24-11-1998
			EP	0979118 A	16-02-2000
US 5671752	A	30-09-1997	CA	2172329 A	01-10-1996
			US	5820560 A	13-10-1998

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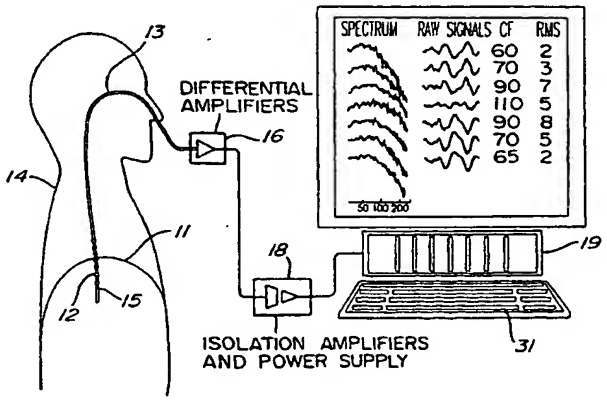
(54) Title: METHOD AND SYSTEM FOR PRODUCING A HIGHER QUALITY ELECTROMYOGRAPHIC SIGNAL FROM AN ELECTRODE ARRAY



(57) Abstract: In a method and system for producing a higher quality electromyographic signal describing myoelectrical activity of an electrically active region of a subject's muscle, a plurality of EMG signals representative of the electrical activity of the electrically active region of the subject's muscle are sensed through an array of electrodes. A weighting function is applied to the detected EMG signals to thereby produce weighted signals, this weighting function containing correction features for the relative locations of the center of the electrically active region and the electrodes. Finally, a sum or mean of a feature of the weighted signals is calculated to thereby produce the higher quality electromyographic signal. Prior to calculating the sum or mean of the weighted signals, electromyographic quality of the weighted signals is evaluated, and the weighted signals or sum or mean of the weighted signals whose evaluated quality is insufficient are replaced. Alternatively, the higher quality electromyographic signal is replaced in response to weighted signals of insufficient quality. The method and system can also be used to determine signal strength or frequency contents of a signal falling outside the array of electrodes.

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METHOD AND SYSTEM FOR PRODUCING A HIGHER QUALITY ELECTROMYOGRAPHIC SIGNAL FROM AN ELECTRODE ARRAY

BACKGROUND OF THE INVENTION

1. Field of the invention:

The present invention relates to a method and system for producing a higher quality electromyographic signal from signals obtained with an array of electrodes, in which the electrode-sensed signals are corrected through implementation of a weighting function.

2. Brief description of the prior art:

The physiological mechanisms which generate myoelectrical activity when a muscle contracts have been known and understood for long time. In particular, how to record electromyographic signals from muscles through an array of electrodes is a well theoretically described topic in physiology.

Although the theoretical understanding is impressive, the bio-physiological application of this theory is, in practice, still partly deficient. As of today, there is known only one standardized and automatic processing system taking into consideration factors such as electrode filtering due to changes in the position of the array of electrodes relative to the center of the electrically active region of the muscle. Application of this technique includes

limitations as to its adaptability to changes in inter-electrode distance and does not optimize the use of signals available along the electrode array with varying anatomy and inter-electrode distance.

Also, the prior art technology fails to provide for full correction of the signals obtained from electrodes of the array that are not symmetrically positioned with respect to the center of the electrically active region of the muscle.

OBJECTS OF THE INVENTION

An object of the present invention is therefore to overcome the above described drawback of the prior art by processing the electrode-sensed signals through a weighting function whose purpose is to correct these electrode-sensed signals for a distance separating the electrodes from the electrically active region of the muscle.

Another object of the present invention is to predict signals which cannot be measured through the array of electrodes.

SUMMARY OF THE INVENTION

More particularly, in accordance with the present invention, there is provided a method of producing a higher quality electromyographic signal describing myoelectrical activity of an electrically active region of a subject's muscle, comprising sensing through an array of electrodes a plurality of EMG (electromyogram) signals representative of the myoelectrical

activity of the electrically active region of the subject's muscle, applying a weighting function to the detected EMG signals and thereby producing weighted signals wherein the weighting function contains correction features for the relative locations of the electrically active region and the electrodes, and combining the weighted signals and thereby producing the higher quality electromyographic signal.

The present invention further relates to a system for producing a higher quality electromyographic signal describing myoelectrical activity of an electrically active region of a subject's muscle, comprising an array of electrodes for sensing a plurality of EMG signals representative of the myoelectrical activity of the electrically active region of the subject's muscle, a weighting filter applied to the detected EMG signals to produce weighted signals wherein the weighting filter contains correction features for the relative locations of the electrically active region and the electrodes, and a combiner of the weighted signals wherein the combined weighted signals constitute the higher quality electromyographic signal.

In accordance with preferred embodiments of the present invention:

- the electrically active region of the subject's muscle comprises a center, the electrodes are separated from the center of the electrically active region by respective distances, the electrodes are separated from each other by an inter-electrode distance, and the weighting function comprises correction features for:
  - the relative location of the center of the electrically active region and the electrodes;
  - the distance separating the center of the electrically active region and the electrodes;
  - the size of the electrically active region; and

– the inter-electrode distance;

- the weighting function comprises correction features for both cancellation and distance damping effects;

- the electrically active region of the subject's muscle comprises a center, the array of electrodes comprises a series of electrodes with an inter-electrode distance, each EMG signal is detected through at least two electrodes of the array, and applying the weighting function comprises:

detecting the position of the center of the electrically active region about the array of electrodes;

relating the weighting function to the position of the center of the electrically active region with respect to the electrodes of the series;

weighting each EMG signal by means of the weighting function related to the position of the center of the electrically active region with respect to the electrodes of the series;

- the series of electrodes has a center and, when the center of the electrically active region is offset with respect to the center of the series of electrodes:

a larger number of EMG signals are detected by the electrodes on one side of the center of the electrically active region than on the other side of that center of the electrically active region so that EMG signals are missing on the above mentioned other side; and

weigthing of the EMG signals comprises replacing the missing EMG signals on the said other side by

corresponding EMG signals from the said one side, and subsequently weighting the replacement EMG signals;

- combining the weighted signals comprises adding a feature of the weighted signals together or calculating a mean of a feature of the weighted signals;

- the method and system further comprise, prior to combining the weighted signals, evaluating electromyographic quality of the weighted signals;

- evaluating electromyographic quality comprises applying to the weighted signals quality indexes for detection of at least one of the following parameters:

  - signal-to-noise ratio;
  - maximum-to-minimum drop in power density;
  - power spectrum deformation;
  - electrical activity related to electrocardiogram/esophageal peristalsis;

- evaluating electromyographic quality comprises adding to each other two of the weighted signals detected through respective electrodes situated on opposite sides of the center of the electrically active region to produce a corresponding addition signal, subtracting these two weighted signals from each other to produce a corresponding subtraction signal, and comparing these addition and substration signals, this comparison being representative of the electromyographic quality of the weighted signals;

- the method and system further comprise, prior to combining the weighted signals, replacing the weighted signals whose evaluated quality is insufficient; and

- the method and system comprise replacing the weighted signals whose evaluated quality is insufficient either by predicted values or by a last value of the weighted signals considered as containing electromyographic information; and

- the method and system comprise replacing the higher quality electromyographic signal in response to weighted signals of insufficient quality.

The objects, advantages and other features of the present invention will become more apparent upon reading of the following non restrictive description of a preferred embodiment thereof, given by way of example only with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the appended drawings:

Figure 1 is a schematic representation of a set-up of an EMG analysis system;

Figure 2 is a section of oesophageal catheter on which an array of electrodes of the EMG analysis system of Figure 1 is mounted;

Figure 3 is a graph showing a set of EMG signals of the diaphragm (EMGdi signals) detected by pairs of successive electrodes of the array of Figure 2;

Figure 4 is a flow chart illustrating the operation of a preferred embodiment of the method and system according to the invention, for producing a higher quality electromyographic signal describing the myoelectrical activity of a muscle;

Figure 5 is a graph showing the distribution of correlation coefficients calculated for determining the position of the center of an electrically active region (EARdi center) of the diaphragm of a subject along the array of electrodes of Figure 2;

Figure 6 is a schematic diagram illustrating the concept embodied by the method and system according to the present invention;

Figure 7 illustrates an exemplary weighting function related to the EMGdi signals collected through the array of electrodes of Figure 2;

Figure 8a is a first graph showing the gain values of a weighting function **W(n)** associated with the various pairs of electrodes of the array, when the center of the electrode array symmetrically overlies the EARdi center and the EARdi center is centered between a pair of electrodes;

Figure 8b is a second graph showing the gain values of a weighting function **W(n)** associated with the various pairs of electrodes of the array, when the center of the electrode pair is shifted with respect to the EARdi center by a distance smaller than 0.5 inter-electrode distance, and the EARdi center is located between the electrodes of the central pair of the electrode array;

Figure 8c is a third graph showing the gain values of a weighting function **W(n)** associated with the various pairs of electrodes of the array, when the center of the array is shifted with respect to the EARdi center by a distance equal to 0.5 inter-electrode distance and the EARdi center overlies an electrode common to both the central electrode pair and another adjacent electrode pair;

Figure 8d is a fourth graph showing the gain values of a weighting function **W(n)** associated with the various pairs of electrodes of the array, when the center of the array is shifted with respect to the EARdi center by a distance between 0.5 and 1.5 inter-electrode distance;

Figure 8e is a fifth graph showing the gain values of a weighting function W(n) associated with the various pairs of electrodes of the array, when the center of the array is shifted with respect to the EARdi center but the EARdi center is centered between a pair of electrodes as in Figure 8a, and two missing EMGdi signals are predicted;

Figure 8f is a sixth graph showing the gain values of a weighting function W(n) associated with the various pairs of electrodes of the array, when the center of the array is shifted with respect to the EARdi center by a distance smaller than 0.5 inter-electrode distance as in Figure 8b, the EARdi center is located but not centered between a pair of electrodes, and two missing EMGdi signals are predicted;

Figure 8g is a seventh graph showing the gain values of a weighting function W(n) associated with the various pairs of electrodes of the array, when the center of the array is shifted with respect to the EARdi center, the EARdi center overlies an electrode of the array as in Figure 8c, and two missing EMGdi signals are predicted;

Figure 9 is a graph showing measured and predicted electrode filtering effects along an array of electrodes such as that shown in Figure 2;

Figure 10 is another graph showing measured electrode filtering effects along an array of electrodes comprising overlapping pairs of electrodes;

Figure 11 is a further graph showing measured electrode filtering effects along the array of electrodes of Figure 2 for an inter-electrode distance of 5 mm; and

Figure 12 is still further a graph showing measured electrode filtering effects along the array of electrodes of Figure 2 for an inter-electrode distance of 10 mm.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Electromyographic signals produced by a muscle can be detected by means of an array of electrodes passing through the center of the muscle electrically active region. The EMG signals detected through the electrodes comprise electromyographic and noise components, and the position of the center of the electrically active region of the muscle can be detected through a reversal of polarity of the electromyographic components of the electrode-sensed EMG signals provided that the polarity of the electrode pairs is consistent from one end to the other of the electrode array.

Although the preferred embodiment of the present invention will be described in relation to an electromyographic signal produced by the

diaphragm of a subject, it should be kept in mind that it is within the scope of the present invention to process a signal representative of the myoelectrical activity of a muscle other than the diaphragm.

According to the preferred embodiment of the present invention, myoelectrical activity of the diaphragm 11 of a human subject 14 is measured through an array of electrodes such as 12 (Figures 1 and 2) mounted on the free end section 15 of an oesophageal catheter 13. As better illustrated in Figure 2, the electrodes 12 are separated by an inter-electrode distance **d**. Figure 1 shows that the catheter 13 is introduced into the subject's oesophagus through one nostril or the mouth until the array of electrodes 12 is situated at the level of the gastroesophageal junction.

An electrode 12 can be mounted on the free end section 15 of the catheter 13 by winding stainless steel wire (not shown) around that catheter 13. The wound stainless steel wire presents a rough surface smoothed out by solder, which in turn is electroplated with nickel, copper and then gold or silver. Of course, it is within the scope of the present invention to use other electrode structures. Also, the electrodes 12 can possibly be applied to a nasogastric feeding tube (not shown) which is routinely introduced in intensive-care unit (ICU) patients.

Electric wires (not shown) interconnect each pair of successive electrodes such as 1-7 (Figure 2) with a respective one of a group of differential amplifiers 16. Obviously, these electric wires follow the catheter 13 from the respective electrodes 12 to the corresponding amplifiers 16, and are preferably integrated to the catheter 13. Preferably, the electric wires transmitting the EMGdi signals (EMG signals from the diaghragm) collected by the various pairs 1-7 of electrodes 12 are shielded to reduce the influence of external noise, in particular disturbance from the 50 or 60 Hz current and voltage of the elecric mains.

The group of differential amplifiers 16 amplifies and band-pass filters each EMGdi signal. This subtraction step can also be carried out in the personal computer 19 when the amplifiers 16 are single-ended or equivalently designed amplifiers (monopolar readings).

In the example illustrated in Figures 1 and 2, the free end section 15 of the catheter 13 is provided with an array of eight electrodes 12 defining seven pairs 1, 2, 3, 4, 5, 6 and 7 of successive electrodes 12 respectively collecting seven different EMGdi signals. Although it has been found that myoelectrical activity of the diaphragm can be measured accurately with an oesophageal catheter 13 provided on the free end section 15 thereof with an array of eight electrodes 12, a different number and/or configuration of pairs of electrodes 12 can be contemplated depending on the subject's anatomy and movement of the diaphragm. Also, the pairs 1-7 do not need to be pairs of successive electrodes; they can be overlapping pairs of electrodes or can present any other configuration of electrode pairs.

A major problem in recording EMGdi signals is to maintain the noise level as low and as constant as possible. Since the electric wires transmitting the EMGdi signals from the electrodes 12 to the differential amplifiers 16 act as an antenna, it is crucial, as indicated in the foregoing description, to shield these electric wires to thereby protect the EMGdi signals from additional artifactual noise. Also, the package enclosing the differential amplifiers 16 is preferably made as small as possible (miniaturized) and is positioned in close proximity to the subject's nose to decrease as much as possible the distance between the electrodes 12 and the amplifiers 16.

The amplified EMGdi signals are sampled by a personal computer 19 through respective isolation amplifiers of a unit 18, to form signal segments of fixed duration. Unit 18 supplies electric power to the various electronic components of the differential and isolation amplifiers while

ensuring adequate isolation of the subject's body from such power supply. The unit 18 also incorporates bandpass filters included in the respective EMGdi signal channels to eliminate the effects of aliasing. The successive EMGdi signal segments are then digitally processed into the personal computer 19 after analog-to-digital conversion thereof. This analog-to-digital conversion is conveniently carried out by an analog-to-digital converter implemented in the personal computer 19. The personal computer 19 includes a monitor 40 and a keyboard 31.

It is believed to be within the capacity of those of ordinary skill in the art to construct suitable differential amplifiers 16 and an adequate isolation amplifiers and power supply unit 18. Accordingly, the amplifiers 16 and the unit 18 will not be further described in the present specification.

An example of the seven EMGdi signals collected by the pairs 1-7 of successive electrodes 12 (Figures 1 and 2) and supplied to the computer 19 is illustrated in Figure 3.

Step 401:

The first operation (step 401 of Figure 4) performed by the computer 19 is a filtering operation to remove from all the EMGdi signals of Figure 3 electrode motion artifacts, cardiac activity, electrical activity related to esophageal peristalsis, 50 and 60 Hz interference from the electric network, and high frequency noise. Implementation of such filtering is believed to be within the capacity of those of ordinary skill in the art and, accordingly, will not be further described.

Steps 402 and 403:

As the diaphragm is generally perpendicular to the longitudinal axis of the oesophageal catheter 13 equipped with an array of electrodes 12, only a portion of the electrodes 12 are situated in the vicinity of the diaphragm. It is therefore important to determine the position of the diaphragm with respect to the oesophageal electrode array. Also, the diaphragm moves during breathing and the method and system according to the invention accounts for this movement of the diaphragm.

The portion of the crural diaphragm 11 which forms the muscular tunnel through which the oesophageal catheter 13 is passed is referred to the "diaphragm electrically active region" (EARdi). The thickness of the EARdi is 20-30 mm. It can be assumed that, within the EARdi, the distribution of active muscle fibers has a center from which the majority of the EMGdi signals originate, i.e. the "diaphragm electrically active region center" (EARdi center). Therefore, when the polarity of the recordings is consistent from one end of the electrode array to the other, EMGdi signals detected on opposite sides of the EARdi center will be reversed in polarity with no phase shift; in other words, EMGdi signals obtained along the electrode array become reversed in polarity at the EARdi center.

Moving centrally from the boundaries of the EARdi, EMGdi power spectrums progressively attenuate and enhance in frequency. Reversal of signal polarity on either side of the electrode pair 4 with the most attenuated power spectrum confirms the position from which the EMGdi signals originate, the EARdi center.

Referring to Figure 4, another function of the computer 19 is to determine the position of the EARdi center along the array of electrodes 12. The EARdi center is repeatedly updated, that is re-determined at predetermined time intervals.

For that purpose, the EMGdi signals are cross-correlated in pairs in step 402 to calculate cross-correlation coefficients **r** in step 403. As well known to those of ordinary skill in the art, cross-correlation is a statistical determination of the phase relationship between two signals and essentially calculates the similarity between two signals in terms of a correlation coefficient **r**. A negative correlation coefficient **r** indicates that the cross-correlated signals are of opposite polarities.

Figure 5 shows curves of the value of the correlation coefficient **r** versus the midpoint between the pairs of electrodes from which the correlated EMGdi signals originate. In this example, the inter-electrode distance is 10 mm. Curves are drawn for distances between the correlated pairs of electrodes 12 of 5 mm (curve 20), 10 mm (curve 21), 15 mm (curve 22) and 20 mm (curve 23). One can appreciate from Figure 5 that negative correlation coefficients **r** are obtained when EMGdi signals from respective electrode pairs situated on opposite sides of the electrode pair 4 are cross-correlated. It therefore appears that the change in polarity occurs in the region of electrode pair 4, which is confirmed by the curves of Figure 3. Accordingly, it can be assumed that the EARdi center is situated substantially midway between the electrodes 12 forming pair 4.

Step 404:

In step 404, the correlation coefficients are systematically compared to determine the EARdi center. For example, the EARdi center can be precisely determined by interpolation using a square law based fit of the three most negative correlation coefficients of curve 21 obtained by successive cross-correlation of the EMGdi signal segments from each electrode pair to the EMGdi signal segments from the second next electrode pair. The EARdi center is associated to a pair of electrodes 12 to provide a

"reference position". In the illustrated example, the EARdi center is associated to pair 4 of electrodes 12.

As mentioned in the foregoing description, the position of the EARdi center along the array of electrodes 12 is continuously updated, i.e. re-calculated at predetermined time intervals overlapping or not.

Step 405:

Each EMGdi signal obtained on either side of the EARdi center is processed, more specifically multiplied/divided/added/subtracted by a weighting function. More specifically, a given parameter of the EMGdi signal is multiplied/divided/added/subtracted by the weighting function. This given parameter may comprise a feature such as, for example, an amplitude, power, area under the rectified signal, etc.

The weighting function can be derived from a mathematical model capable of adjusting each EMGdi signal in relation to the relative position of the array of electrodes 12 with respect to the EARdi center. The weighting function can also be obtained from weighting-function-describing data measured on the subject's body, for example by measuring EMGdi signals along the electrode array with knowledge of the position of the EARdi center. Finally the weighting function can be derived from both the mathematical model and the weighting function describing data measured on the subject's body. Also, the processing can be performed in the time domain or in the frequency domain.

The weighting function contains correction for:

- the relative location of the EARdi center with respect to the pairs of electrodes through which the EMGdi signals are obtained;

- the distance separating the EARdi center from the electrodes;

- the size of the electrically active region (EARdi) of the diaphragm; and

- the inter-electrode distance.

Knowing the position of the center of the electrically active region of the diaphragm (EARdi) about the array or electrodes, the mathematical model can produce weighting functions correcting for both cancellation effects and distance damping effects.

For the purpose of illustrating this concept, let's consider Figure 6 in which wanted signals **S** from a wanted signal source 601 and disturbance signals **D** from disturbances 602 are detected through an array of electrodes 603. The array of electrodes comprises **N** electrodes labeled **n**, where **n** = 1, 2, 3, 4 ... **N**. The array of electrodes does not have to be linearly arranged; any configuration is possible.

The signal detected through a given electrode **n** depends on 1st) the properties of the sources 601 and 602 (point sources or line sources with particular direction or curved line sources) and 2nd) the distances $\mathbf{r_s(n)}$ and $\mathbf{r_d(n)}$, respectively, between the sources 601 and 602 and the electrode **n**. Line source signals display a mixed frequency and distance dependent damping essentially described by modified bessel functions while point source signals are damped inversely proportional to the distance and independent of frequency.

The signal from each electrode is processed through the weighting function **W(n)**, which is a weighting filter which may be positive,

negative or even equal to zero prior to a summation of all contributions (**n** = 1 to **N**) to give the output signal.

The following relations describe signal conditioning in the spectral domain:

the signal **u(n)** at the given electrode **n** is

$$u(n) = S\, f_s[r_s(n)] + D\, f_d[r_d(n)] \qquad (1)$$

the output signal **Out** 604 is:

$$Out = \sum_{n=1}^{N} u(n)\, W(n) \qquad (2)$$

Combining the two equations and rearranging the terms give the following expression:

$$Out = S \sum_{n=1}^{N} f_s[r_s(n)]\, W(n) + D \sum_{n=1}^{N} f_d[r_d(n)]\, W(n) \qquad (3)$$

where f_s and f_d are functions describing damping and/or other alteration (such as interference) to the signal as a function of distances r_s and r_d, respectively.

Figure 7 is a graph illustrating an example of weighting function **W(n)**. As can be seen the graph of Figure 7 relates the weighting function **W(n)** to the position of the pairs of electrodes from which the EMGdi signals of Figure 3 originate, and the center of the EARdi determined through the correlation coefficients **r** in steps 402-404.

In Figure 7, curve 701 illustrating the weighting function **W(n)** shows that signals from electrode pairs 1, 2, 3, 4, 5, 6 and 7 are represented by

respective local gain values of the weighting function **W(n)**. The local gain values for all electrode pairs is determined by the position of the EARdi center along the array of electrodes. More specifically, the local gain value of electrode pair 4 is the gain value of curve 701 determined by the position of the EARdi center itself centered between the electrodes of pair 4 (see dashed line 702). The local gain value of electrode pairs 1, 2, 3, 5, 6 and 7 is the gain value of curve 701 at positions shifted from the EARdi center by a corresponding number of inter-electrode distances (see dashed lines 703-708). In the illustrated example, the signal from electrode pair 1 will be represented by gain value 0.05 (dashed line 703), the signal from electrode pair 2 will be represented by gain value 0.3 (dashed line 704), the signal from electrode pair 3 will be represented by gain value 0.9 (dashed line 705), the signal from electrode pair 4 will be represented by gain value 0.3 (dashed line 702), the signal from electrode pair 5 will be represented by gain value 0.9 (dashed line 706), the signal from electrode pair 6 will be represented by gain value 0.3 (dashed line 707), and the signal from electrode pair 7 will be represented by gain value 0.05 (dashed line 708).

In general terms, for a good performance, the first term of Equation 3 should be maximized and the second term minimized, or depending on the application of concern, known filtering strategies should be used to optimize the spectral distributions of wanted and disturbance signals. The optimization is performed by varying sign, strength, and spectral (complex) contents of the weighting filter W(n). This process can be guided by a priori knowledge of the type of signal source (line, point, etc.) and the corresponding type of damping (modified bessel functions, inverse distance damping, etc.) and/or experimental knowledge of the signals spectral content.

Figures 8a-8c are graphs showing the effect of moving the EARdi center along the array of electrodes from a position in which the EARdi center is located centrally between a pair of electrodes to a position in which the

EARdi center overlies an electrode. These graphs clearly show how the signal amplitudes along the array of electrodes are affected by alteration of the position of the EARdi center with respect to the electrode pair 4.

The graph of Figure 8a shows the gain values of the weighting function **W(n)** associated with the various pairs of electrodes of the array, when the center of the electrode array symmetrically overlies the EARdi center and the EARdi center is centered between the central electrode pair 4. The position of the EARdi center is the same as illustrated in Figure 7. In Figure 8a, electrode filtering is symmetrical and presents cancellation at electrode pair 4.

The graph of Figure 8b illustrates the gain values of a weighting function **W(n)** associated with the various pairs of electrodes of the array, when the center of the array is shifted with respect to the EARdi center by a distance smaller than 0.5 inter-electrode distance. More specifically, in Figure 8b, the EARdi center is moved (upwardly in the figure) by 25% of the inter-electrode distance. In this example, the weighting function is skewed, but there is still some cancellation at electrode pair 4.

Figure 8c is a third graph showing the gain values of a weighting function **W(n)** associated with the various pairs of electrodes of the array, when the center of the array is shifted with respect to the EARdi center by a distance equal to 0.5 inter-electrode distance and the EARdi center is centered on an electrode. The resulting weighting function is symmetrical with no cancellation at electrode pair 4.

The above Figures 8a, 8b and 8c show three (3) possible locations of the EARdi center relative to an electrode pair centered on the electrode array. The fourth figure, namely Figure 8d, exemplifies the behavior of the signals if the EARdi center continues to move over to an adjacent electrode

pair. In this latter case, the gain values are the same as in Figure 8b but are reversed.

Figures 8e, 8f and 8g show the same positional shifts as in Figures 8a, 8b and 8c but when the EARdi center is located at electrode pair 2 instead of central electrode pair 4. The EMGdi signals corresponding to weighting function gain values **W(n+2)** and **W(n+3)** then fall outside of the electrode array. The missing weighted signals can then be predicted by using the same EMGdi signal detected at electrode pairs 4 and 3 processed through the weighting function. These predicted values are then used in the calculation for the total signal strength across the electrode array.

In this preferred embodiment, the electrodes at the bottom of the array (Figures 8e-g) are not used. However, depending on how complex the model for prediction and computation is, these signals can also be used. If correction for signals that fall off the electrode array is not performed, it is impossible to obtain an accurate estimate of the total signal value.

Just a word to mention that the weighting function **W(n)** of the Figures 7 and 8 regards conditioning of the amplitude of the EMGdi signal and corresponds to curve 901 of Figure 9 (curve of the amplitude of the EMGdi signal in relation to the distance of the electrodes of the pair from the EARdi center). The EMGdi signals can also be frequency conditioned by constructing a weighting filter using a curve such as 902 in Figure 9 (curve of the center frequency of the EMGdi signal in relation to the distance of the electrodes of the pair from the EARdi center). A combination of frequency and amplitude conditioning can also be implemented.

Figures 10, 11 and 12 are other examples of amplitude and frequency conditioning curves that can serve as weighting functions **W(n)**.

The curves of Figures 9, 10, 11 and 12 are usually experimentally established on a sufficient number of recordings in a subject.

Step 406:

In this step, electromyographic quality of the weighted signals is evaluated.

This evaluation of the electromyographic quality of all the weighted signals can be performed for their relative electromyographic and noise components. Thus, if preferred, summation of the EMGdi signals (amplitude, area under the curve, power, etc.) along the array of electrodes can be limited to signals that contain physiological information pertaining to the diaphragm. This evaluation of signals content can be performed by applying well known signal quality indexes for detection of signal-to-noise ratio, maximum-to-minimum drop in power density, power spectrum deformation, and/or electrocardiogram/esophageal peristalsis.

This evaluation of signals for their relative electromyographic and noise components can also be obtained by adding and subtracting EMGdi signals obtained on opposite sides with symmetrical position to the electrically active region center (for example signals from electrode pairs 3 and 5 in Figure 7) and comparing the results of these addition and subtraction. A first EMGdi signal detected by a pair of electrodes of the array on a first side of the center of the EARdi has an electromyographic component of a first polarity and a noise component of given polarity. A second EMGdi signal detected by another pair of electrodes of the array on the second side of the EARdi center, opposite to the first side, has an electromyographic component of a second polarity opposite to the first polarity and a noise component of said given polarity. Subtraction of the first and second EMGdi signals subtracts the noise components of the first and second EMGdi signals from each other

but adds the electromyographic components of these first and second EMGdi signals together to produce a resulting signal with high electromyographic content and low noise content. Addition of the first and second EMGdi signals adds the noise components of the first and second EMGdi signals to each other but subtracts the electromyographic components of these first and second EMGdi signals from each other to produce a signal with low electromyographic content and high noise content. Comparison of the resulting added and subtracted signals (area under the curve/power/amplitude of the signals) provides information about the relative contribution of noise and electromyographic content to the signal. Signals with a high electromyographic content will be considered as a high quality signal.

Step 407:

EMGdi signals considered as not containing physiological information (insufficient quality as determined in step 406) pertaining to the diaphragm can be replaced by predicted values or simply the last value considered to contain physiological information pertaining to the diaphragm. This replacement strategy can be applied on either each single EMGdi signal obtained from the electrode array or on the summation or mean of the weighted EMGdi signals representative for all or some of the signals obtained along the electrode array.

Step 408:

The last step consists of calculating the sum of a feature (RMS voltage, RMS current, power, RMS means amplitude, area under the curve, etc) of the eventually replaced, signal quality evaluated weighted EMGdi signals from the electrodes of the array. A mean of the rectified signals, or a

RMS or other suitable or equivalent value of these signals can be calculated as well for further use.

The resulting signal will provide improvement of the signal-to-noise ratio and minimize influence of electrode filtering due to changes in the position of the electrode array relative the muscle's electrically active region center. It also accounts for differences in anatomy between individuals and differences in inter-electrode distance and design, and for the EARdi center approaching the distal or proximal end of the array of electrodes.

Of course, the application of the present invention is not limited to the diaphragm but to any other muscle and that, for any type of array of electrodes.

Although the present invention has been described hereinabove by way of a preferred embodiment thereof, this embodiment can be modified at will, within the scope of the appended claims, without departing from the spirit and nature of the subject invention.

WHAT IS CLAIMED IS:

1. A method of producing a higher quality electromyographic signal describing myoelectrical activity of an electrically active region of a subject's muscle, comprising:

sensing through an array of electrodes a plurality of EMG signals representative of the myoelectrical activity of the electrically active region of the subject's muscle;

applying a weighting function to the detected EMG signals and thereby producing weighted signals, the weighting function containing correction features for the relative locations of the electrically active region and the electrodes; and

combining the weighted signals and thereby producing the higher quality electromyographic signal.

2. A method of producing a higher quality electromyographic signal as defined in claim 1, wherein:

the electrically active region of the subject's muscle comprises a center;

the electrodes are separated from the center of the electrically active region by respective distances;

the electrodes are separated from each other by an inter-electrode distance; and

the weighting function comprises correction features for:

– the relative location of the center of the electrically active region and the electrodes;

– the distance separating the center of the electrically active region and the electrodes;

– the size of the electrically active region; and

– the inter-electrode distance.

3. A method of producing a higher quality electromyographic signal as defined in claim 1, wherein the weighting function comprises correction features for both cancellation and distance damping effects.

4. A method of producing a higher quality electromyographic signal as defined in claim 1, wherein the electrically active region of the subject's muscle comprises a center, the array of electrodes comprises a series of electrodes with an inter-electrode distance, each EMG signal is detected through at least two electrodes of the array, and wherein applying the weighting function comprises:

detecting the position of the center of the electrically active region about the array of electrodes;

relating the weighting function to the position of the center of the electrically active region with respect to the electrodes of said series;

weighting each EMG signal by means of the weighting function related to the position of the center of the electrically active region with respect to the electrodes of said series.

5. A method of producing a higher quality electromyographic signal as defined in claim 4, wherein the series of electrodes has a center, and wherein, when the center of the electrically active region is offset with respect to the center of the series of electrodes:

a larger number of EMG signals are detected by the electrodes on one side of the center of the electrically active region than on the other side of said center of the electrically active region so that EMG signals are missing on said other side; and

weigthing of the EMG signals comprises replacing the missing EMG signals on said other side by corresponding EMG

signals from said one side and subsequently weighting said replacement EMG signals.

6. A method of producing a higher quality electromyographic signal as defined in claim 1, wherein combining the weighted signals comprises:

adding a feature of the weighted signals together.

7. A method of producing a higher quality electromyographic signal as defined in claim 1, wherein combining the weighted signals comprises;

calculating a mean of a feature of the weighted signals.

8. A method of producing a higher quality electromyographic signal as defined in claim 1, further comprising, prior to combining the weighted signals, evaluating electromyographic quality of the weighted signals.

9. A method of producing a higher quality electromyographic signal as recited in claim 8, wherein evaluating electromyographic quality comprises applying to the weighted signals quality indexes for detection of at least one of the following parameters:

- signal-to-noise ratio;
- maximum-to-minimum drop in power density;
- power spectrum deformation;
- electrical activity related to electrocardiogram/esophageal peristalsis.

10. A method of producing a higher quality electromyographic signal as recited in claim 8, wherein the electrically active

region of the subject's muscle comprises a center, and wherein evaluating electromyographic quality comprises adding to each other two of the weighted signals detected through respective electrodes situated on opposite sides of the center of the electrically active region to produce a corresponding addition signal, subtracting said two weighted signals from each other to produce a corresponding subtraction signal, and comparing said addition and substration signals, said comparision being representative of the electromyographic quality of the weighted signals.

11. A method of producing a higher quality electromyographic signal as recited in claim 8, further comprising, prior to combining the weighted signals, replacing the weighted signals whose evaluated quality is insufficient.

12. A method of producing a higher quality electromyographic signal as recited in claim 11, comprising replacing the weighted signals whose evaluated quality is insufficient by predicted values.

13. A method of producing a higher quality electromyographic signal as recited in claim 11, comprising replacing the weighted signals whose evaluated quality is insufficient by a last value of said weighted signals considered as containing electromyographic information.

14. A method of producing a higher quality electromyographic signal as recited in claim 8, comprising replacing the higher quality electromyographic signal in response to weighted signals of insufficient quality.

15. A system for producing a higher quality electromyographic signal describing myoelectrical activity of an electrically active region of a subject's muscle, comprising:

an array of electrodes for sensing a plurality of EMG signals representative of the myoelectrical activity of the electrically active region of the subject's muscle;

a weighting filter applied to the detected EMG signals to produce weighted signals, the weighting filter containing correction features for the relative locations of the electrically active region and the electrodes; and

a combiner of the weighted signals, the combined weighted signals constituting the higher quality electromyographic signal.

16. A system for producing a higher quality electromyographic signal as defined in claim 15, wherein:

the electrically active region of the subject's muscle comprises a center;

the electrodes are separated from the center of the electrically active region by respective distances;

the electrodes are separated from each other by an inter-electrode distance; and

the weighting filter comprises correction features for:

- the relative location of the center of the electrically active region and the electrodes;
- the distance separating the center of the electrically active region and the electrodes;
- the size of the electrically active region; and
- the inter-electrode distance.

17. A system for producing a higher quality electromyographic signal as defined in claim 15, wherein the weighting filter comprises correction features for both cancellation and distance damping effects.

18. A system for producing a higher quality electromyographic signal as defined in claim 15, wherein:

the electrically active region of the subject's muscle comprises a center;

the array of electrodes comprises a series of electrodes with an inter-electrode distance;

each EMG signal is detected through at least two electrodes of the array; and

the weighting filter comprises a weighting function related to the position of the center of the electrically active region with respect to the electrodes of said series.

19. A system for producing a higher quality electromyographic signal as defined in claim 15, wherein the series of electrodes has a center, and wherein, when the center of the electrically active region is offset with respect to the center of the series of electrodes:

a larger number of EMG signals are detected by the electrodes on one side of the center of the electrically active region than on the other side of said center of the electrically active region so that EMG signals are missing on said other side; and

the system comprises means for replacing the missing EMG signals on said other side by corresponding EMG signals from said one side, and means for subsequently weighting said replacement EMG signals.

20. A system for producing a higher quality electromyographic signal as defined in claim 15, wherein the combiner comprises:

an adder of a feature of the weighted signals.

21. A system for producing a higher quality electromyographic signal as defined in claim 15, wherein the combiner comprises:

a calculator of a mean of a feature of the weighted signals.

22. A system for producing a higher quality electromyographic signal as defined in claim 15, further comprising, prior to combining the weighted signals, an evaluator of an electromyographic quality of the weighted signals.

23. A system for producing a higher quality electromyographic signal as recited in claim 22, wherein the evaluator comprises means for applying to the weighted signals quality indexes for detection of at least one of the following parameters:

- signal-to-noise ratio;
- maximum-to-minimum drop in power density;
- power spectrum deformation;
- electrical activity related to electrocardiogram/esophageal peristalsis.

24. A system for producing a higher quality electromyographic signal as recited in claim 22, wherein the electrically active region of the subject's muscle comprises a center, and wherein the evaluator comprises an adder of two of the weighted signals detected through respective electrodes situated on opposite sides of the center of the electrically active region to produce a corresponding addition signal, a subtractor of said two weighted signals from each other to produce a corresponding subtraction signal, and a comparator of said addition and substration signals, this comparision being representative of the electromyographic quality of the weighted signals.

25. A system for producing a higher quality electromyographic signal as recited in claim 22, further comprising means for replacing, prior to combining the weighted signals, the weighted signals whose evaluated quality is insufficient.

26. A system for producing a higher quality electromyographic signal as recited in claim 25, comprising means for replacing the weighted signals whose evaluated quality is insufficient by predicted values.

27. A system for producing a higher quality electromyographic signal as recited in claim 25, comprising means for replacing the weighted signals whose evaluated quality is insufficient by a last value of said weighted signals considered as containing electromyographic information.

28. A system for producing a higher quality electromyographic signal as recited in claim 22, comprising means for replacing the higher quality electromyographic signal in response to weighted signals of insufficient quality.

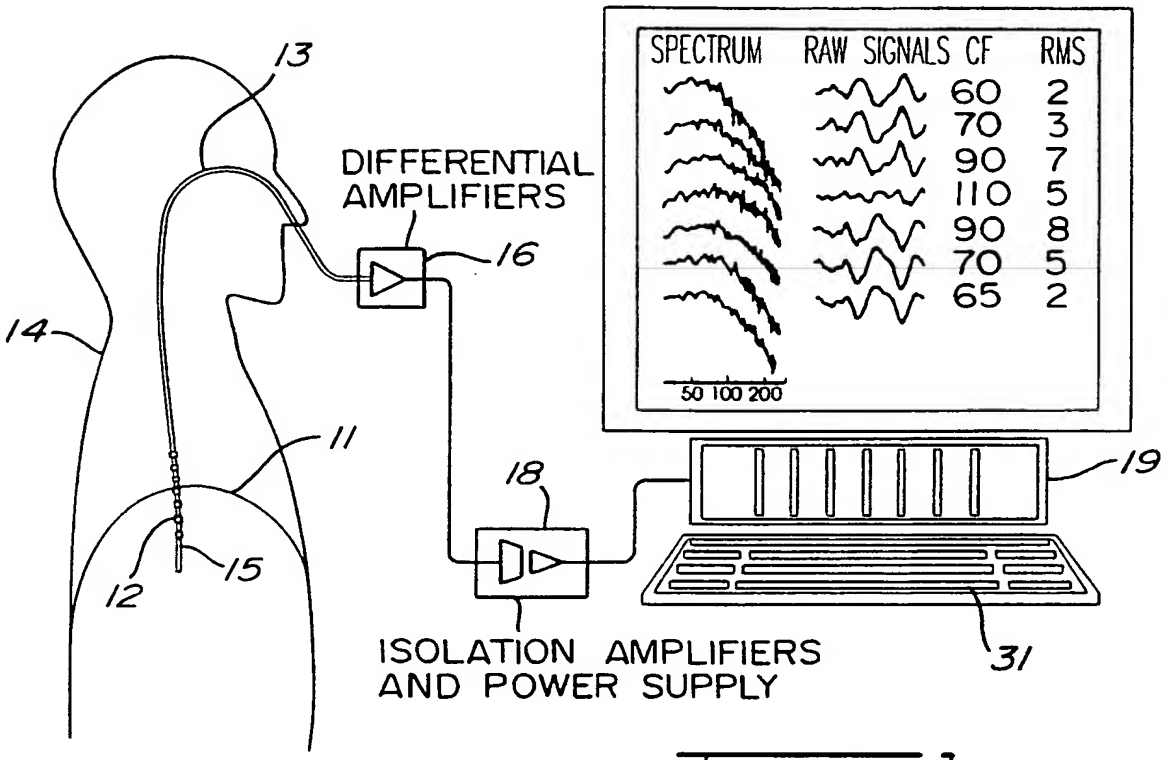
13
DIFFERENTIAL AMPLIFIERS
16
14
11
18
19
12
15
SPECTRUM
RAW SIGNALS
CF
RMS
60 2
70 3
90 7
110 5
90 8
70 5
65 2
50 100 200
ISOLATION AMPLIFIERS AND POWER SUPPLY
31

Fig. 1

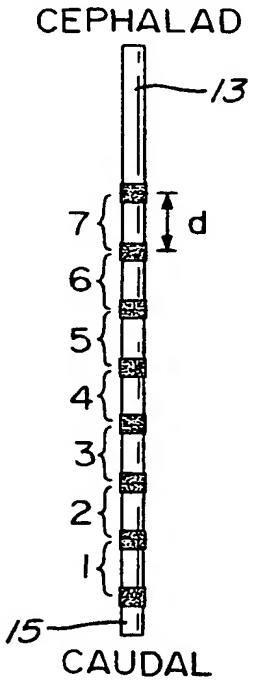
CEPHALAD
13
7
6
5
4
3
2
1
d
15
CAUDAL

Fig. 2

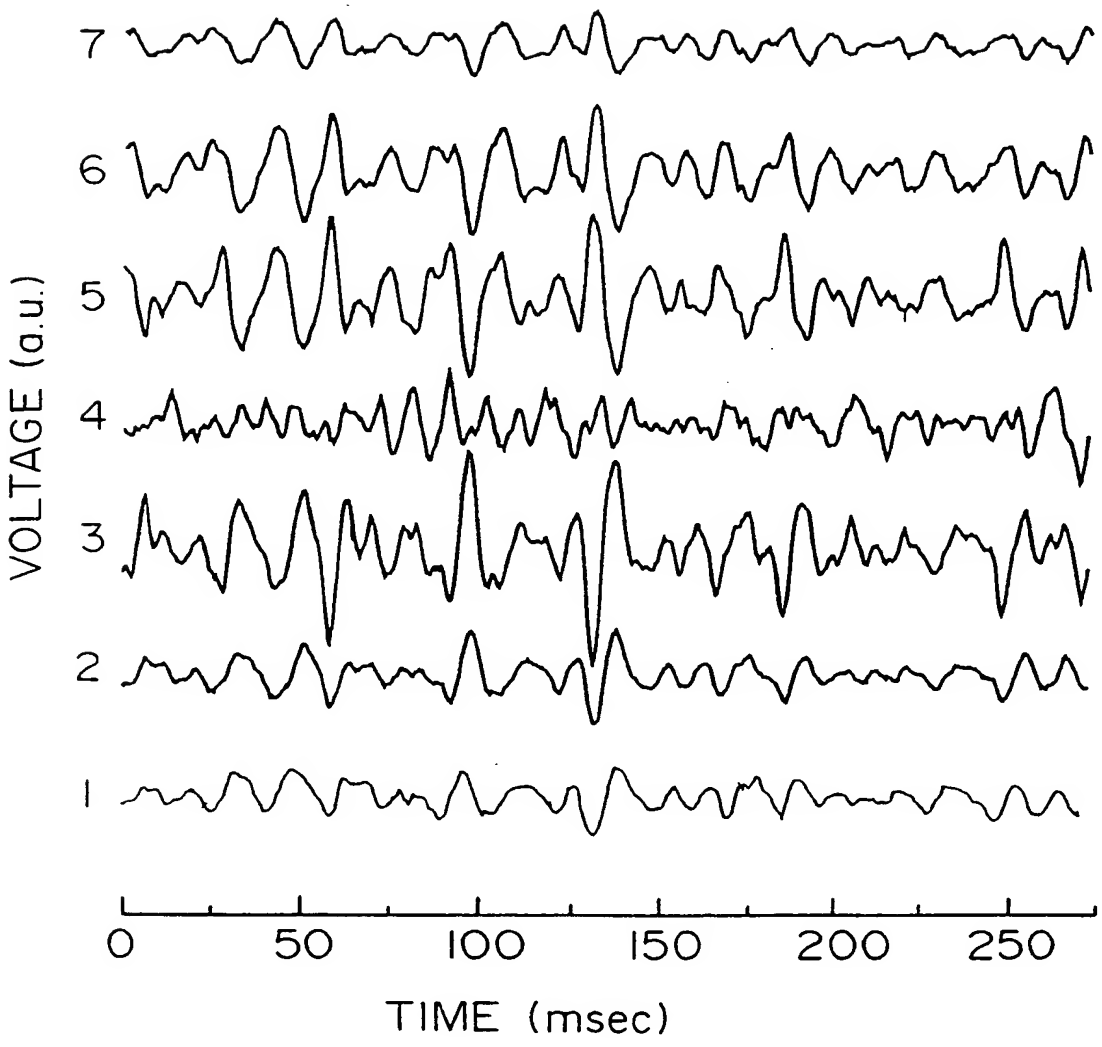

Fig. 3

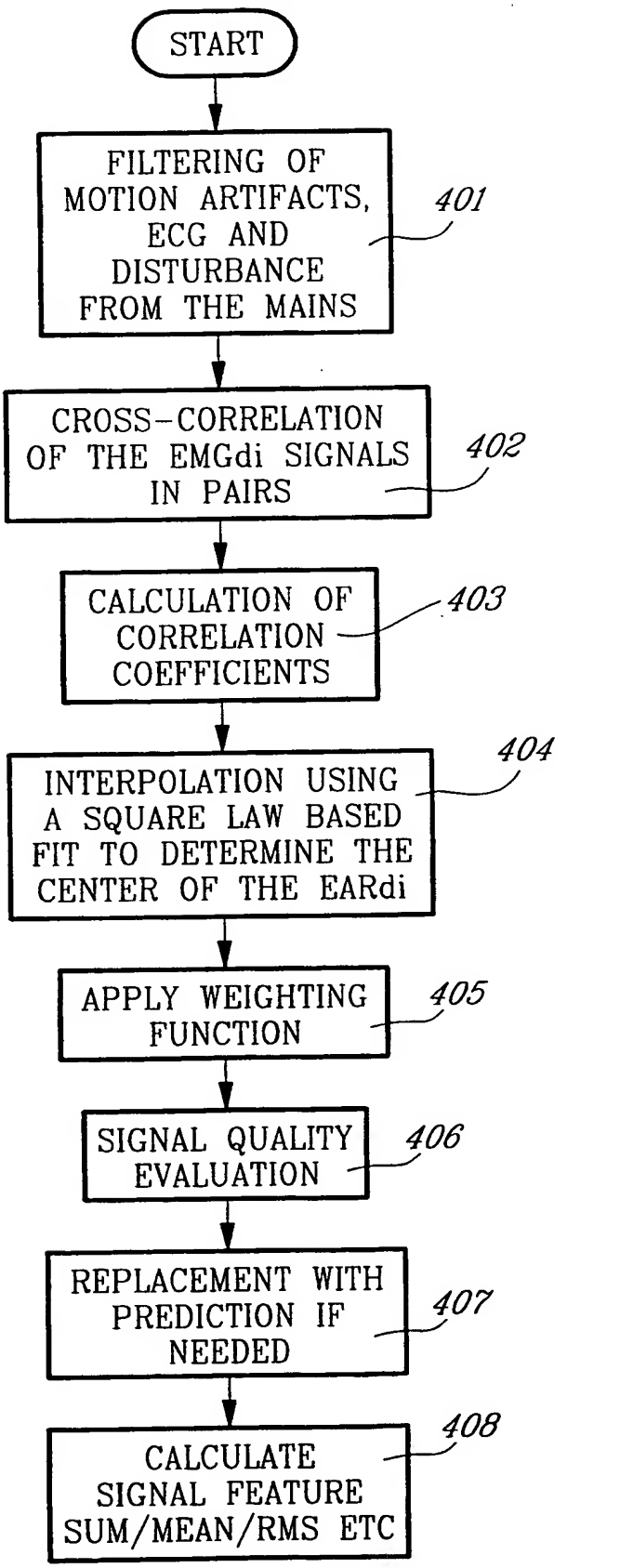
START
FILTERING OF MOTION ARTIFACTS, ECG AND DISTURBANCE FROM THE MAINS
401
CROSS-CORRELATION OF THE EMGdi SIGNALS IN PAIRS
402
CALCULATION OF CORRELATION COEFFICIENTS
403
INTERPOLATION USING A SQUARE LAW BASED FIT TO DETERMINE THE CENTER OF THE EARdi
404
APPLY WEIGHTING FUNCTION
405
SIGNAL QUALITY EVALUATION
406
REPLACEMENT WITH PREDICTION IF NEEDED
407
CALCULATE SIGNAL FEATURE SUM/MEAN/RMS ETC
408

Fig. 4

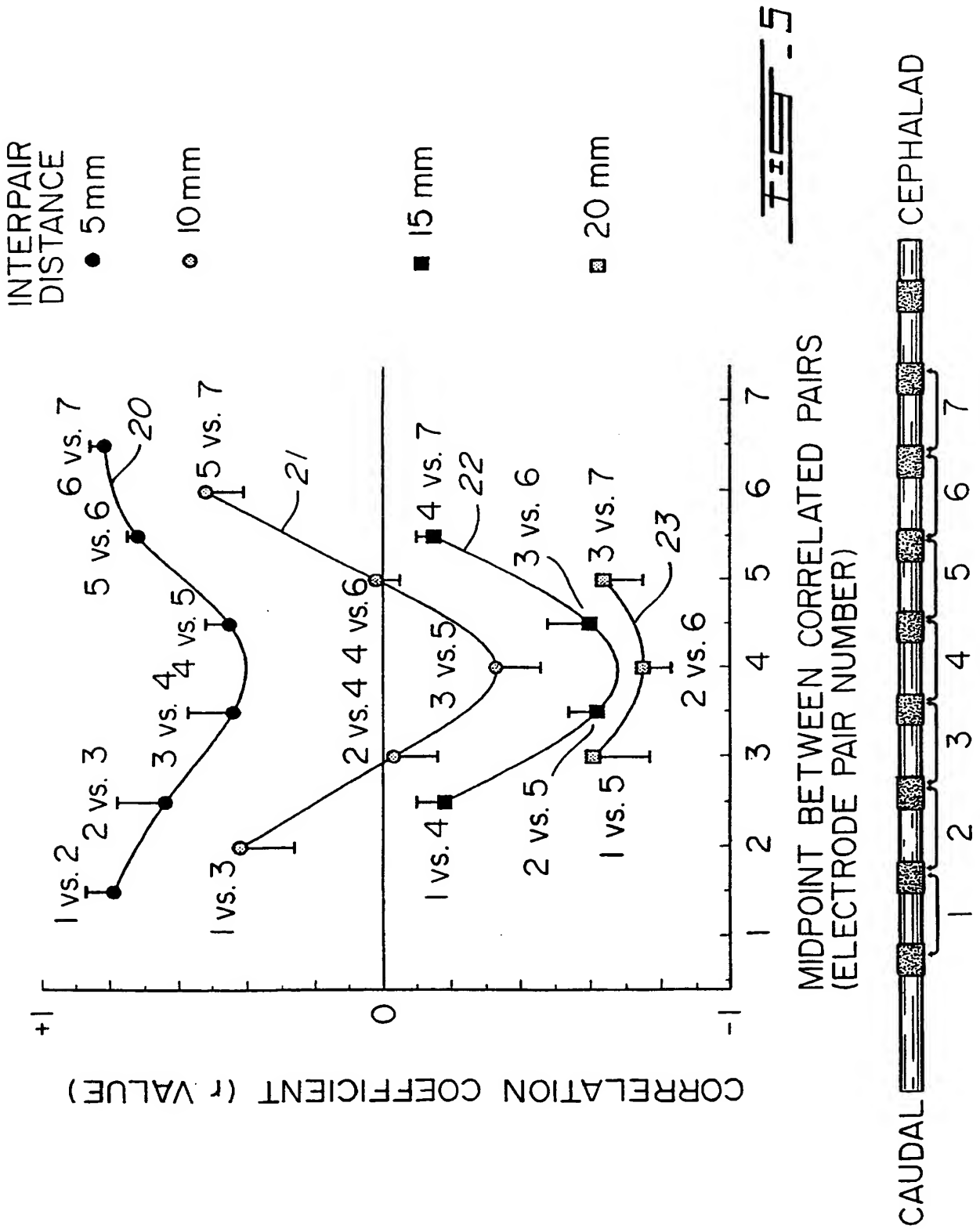
INTERPAIR DISTANCE
5 mm
10 mm
15 mm
20 mm
1 vs. 2
2 vs. 3
3 vs. 4
4 vs. 5
5 vs. 6
6 vs. 7
20
1 vs. 3
2 vs. 4
3 vs. 5
4 vs. 6
5 vs. 7
21
1 vs. 4
2 vs. 5
3 vs. 6
4 vs. 7
22
1 vs. 5
2 vs. 6
3 vs. 7
23
+1
0
-1
CORRELATION COEFFICIENT (r VALUE)
1 2 3 4 5 6 7
MIDPOINT BETWEEN CORRELATED PAIRS (ELECTRODE PAIR NUMBER)
CAUDAL
CEPHALAD
1 2 3 4 5 6 7

Fig - 5

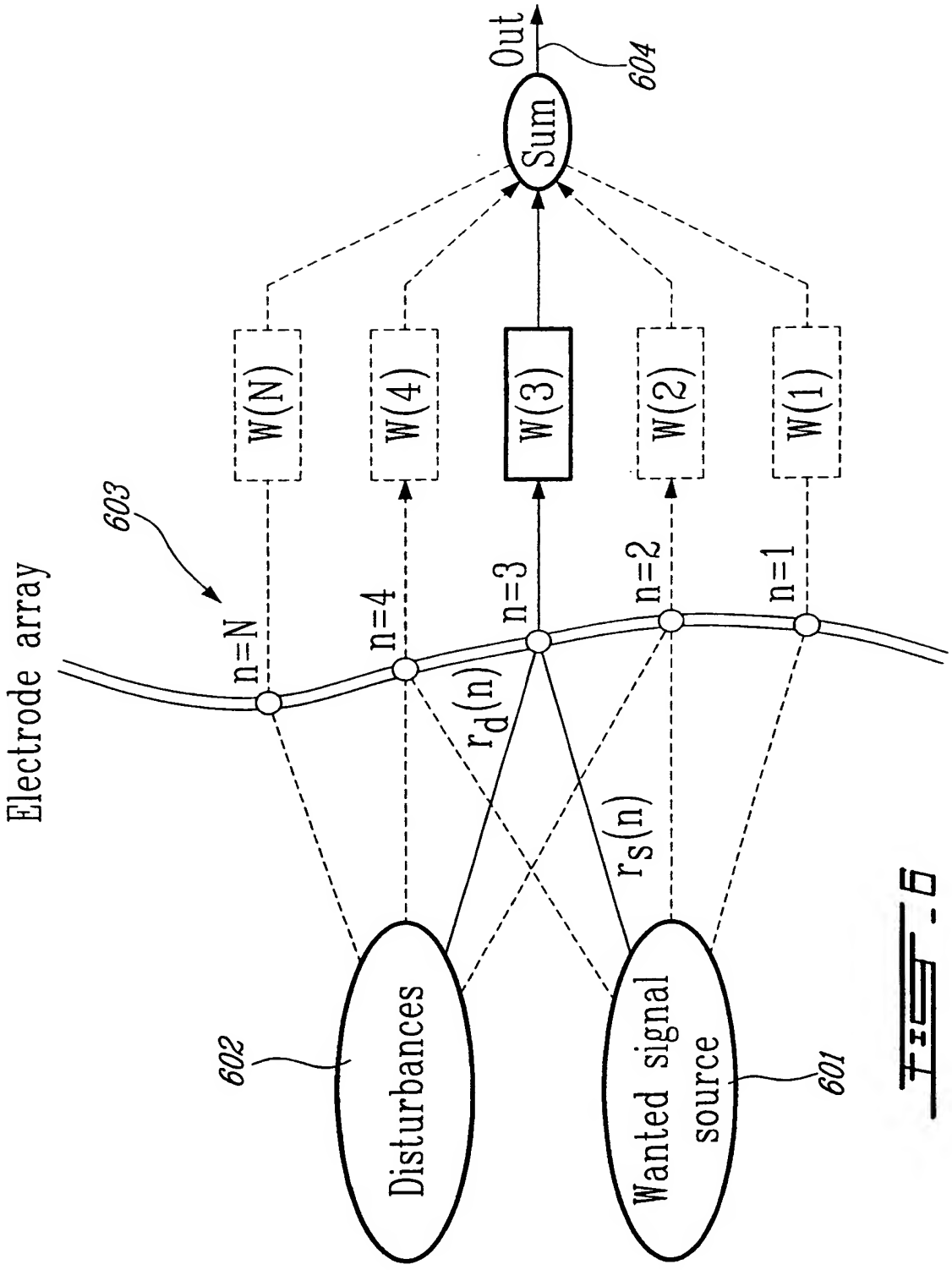
Out
604
Sum
W(N)
W(4)
W(3)
W(2)
W(1)
603
Electrode array
n=N
n=4
n=3
n=2
n=1
$r_d(n)$
$r_s(n)$
602
Disturbances
Wanted signal source
601

FIG. 6

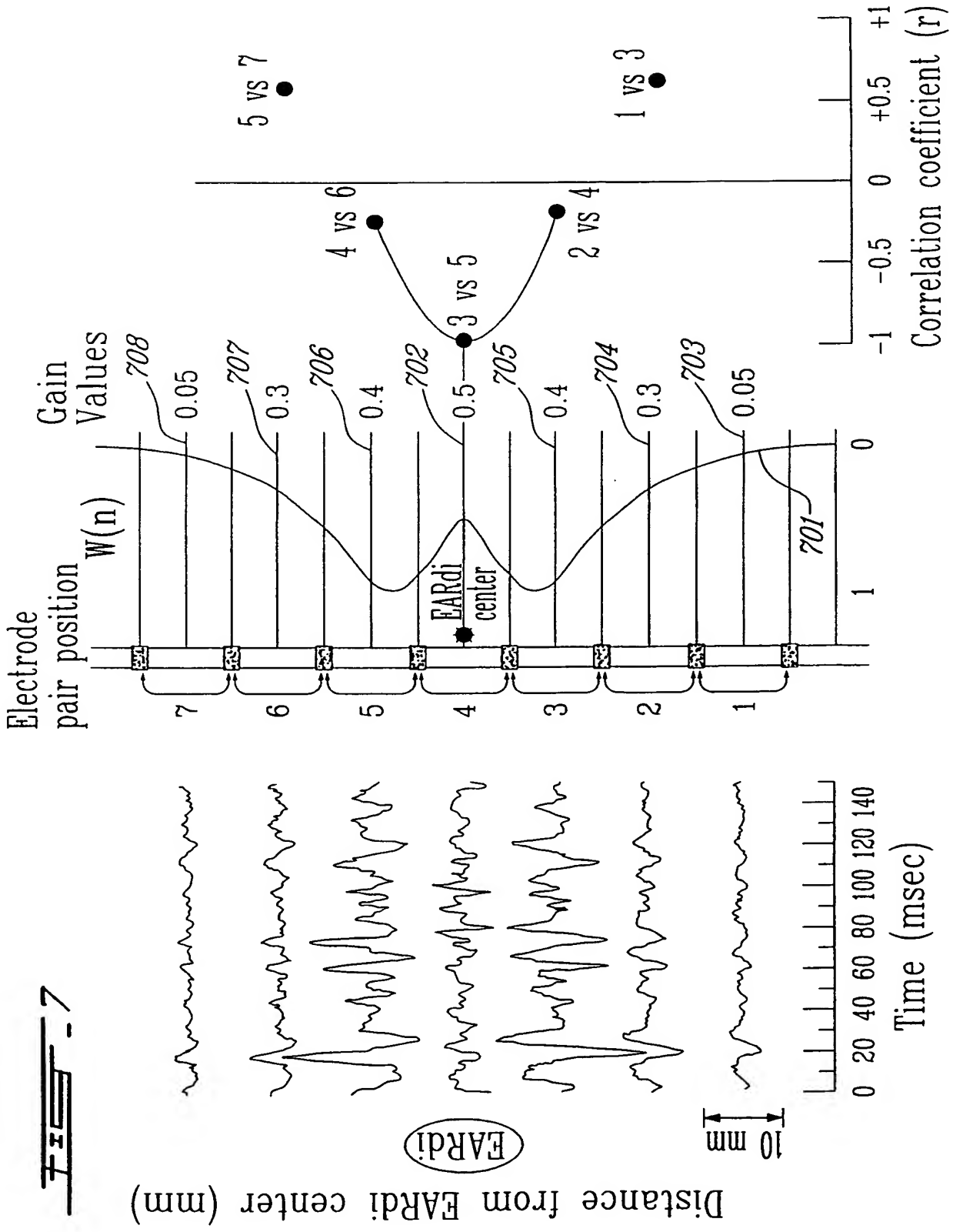
Electrode pair position
W(n)
Gain Values
708
0.05
707
0.3
706
0.4
702
0.5
705
0.4
704
0.3
703
0.05
701
EARdi center
7
6
5
4
3
2
1
0
1
4 vs 6
3 vs 5
2 vs 4
5 vs 7
1 vs 3
−1 −0.5 0 +0.5 +1
Correlation coefficient (r)
0 20 40 60 80 100 120 140
Time (msec)
10 mm
EARdi
Distance from EARdi center (mm)

Fig. 7

Fig. 8a

Fig. 8b

Fig. 8c

Electrode pair position W(n)
W(n-3)
W(n-2)
W(n-1)
W(n)
W(n+1)
W(n+2)
W(n+3)
EARdi
EARdi center
7
6
5
4
3
2
1
10 mm
Distance from EARdi center (mm)
Signal amplitude relative electrode pair 6

Fig. 8e

Electrode pair position W(n)
W(n-3)
W(n-2)
W(n-1)
W(n)
W(n+1)
W(n+2)
W(n+3)
EARdi
EARdi center
7
6
5
4
3
2
1
10 mm
Distance from EARdi center (mm)
Signal amplitude relative electrode pair 4

Fig. 8d

Electrode
pair position W(n)
W(n-3)
W(n-2)
W(n-1)
W(n)
W(n+1)
W(n+2)
W(n+3)
EARdi
center
7
6
5
4
3
2
1
10 mm
Distance from EARdi center (mm)
Signal amplitude
relative electrode
pair 6

Fig - 8f

Electrode
pair position W(n)
W(n-3)
W(n-2)
W(n-1)
W(n)
W(n+1)
W(n+2)
W(n+3)
EARdi
center
7
6
5
4
3
2
1
10 mm
Distance from EARdi center (mm)
Signal amplitude
relative ep(n)

Fig - 8g

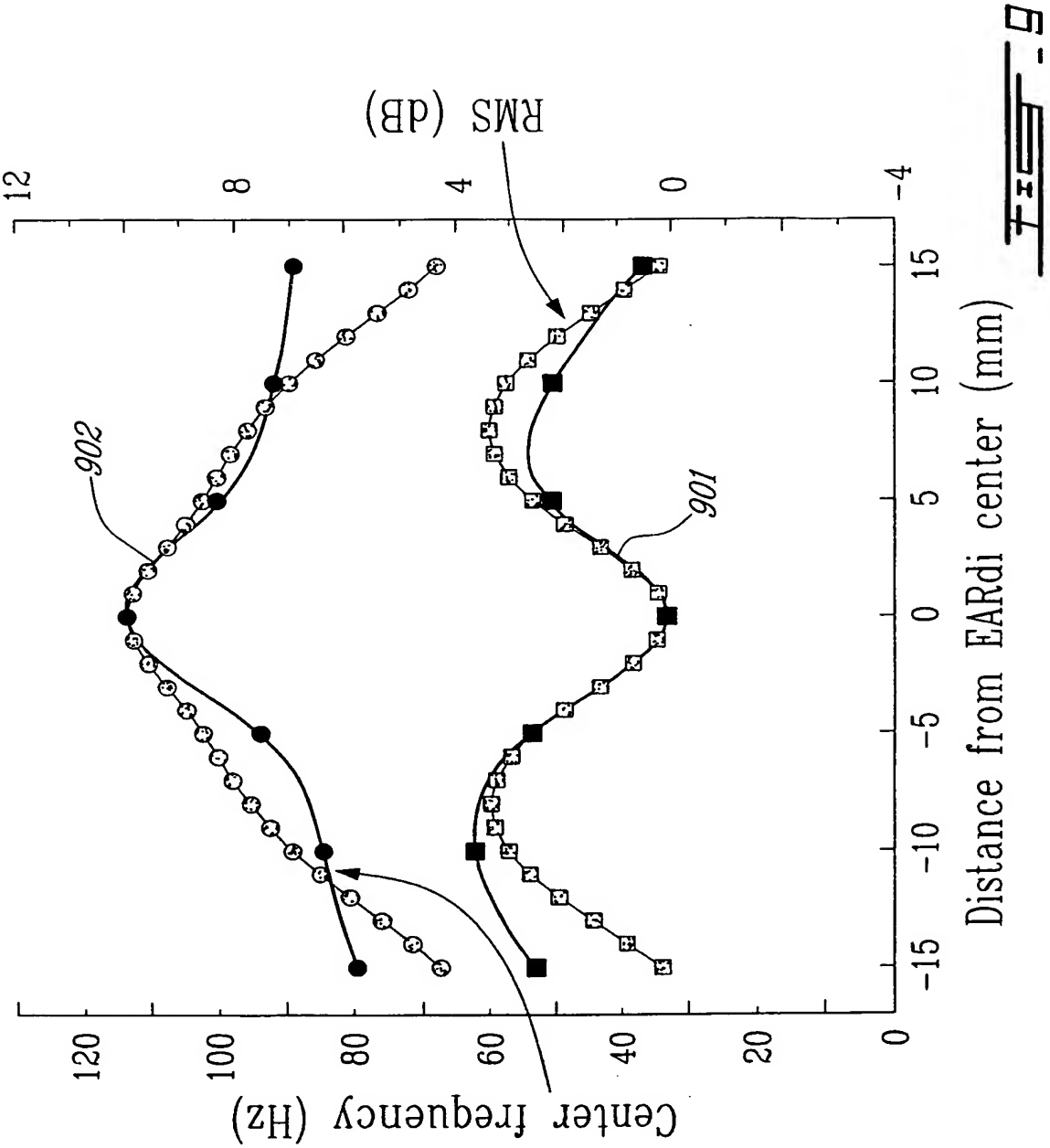
RMS (dB)
12
8
4
0
-4
902
901
Center frequency (Hz)
120
100
80
60
40
20
0
-15
-10
-5
0
5
10
15
Distance from EARdi center (mm)

Fig. 9

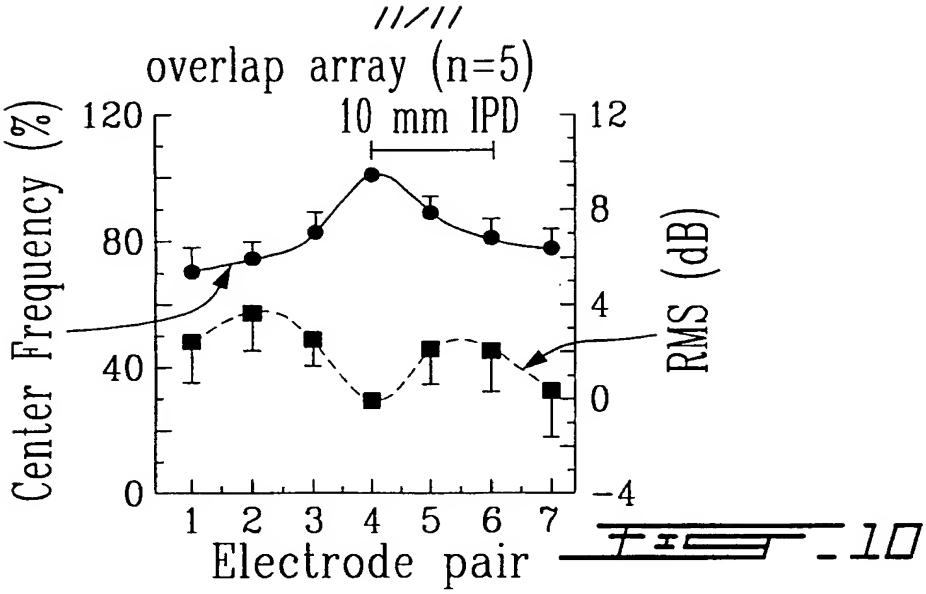

Fig. 10

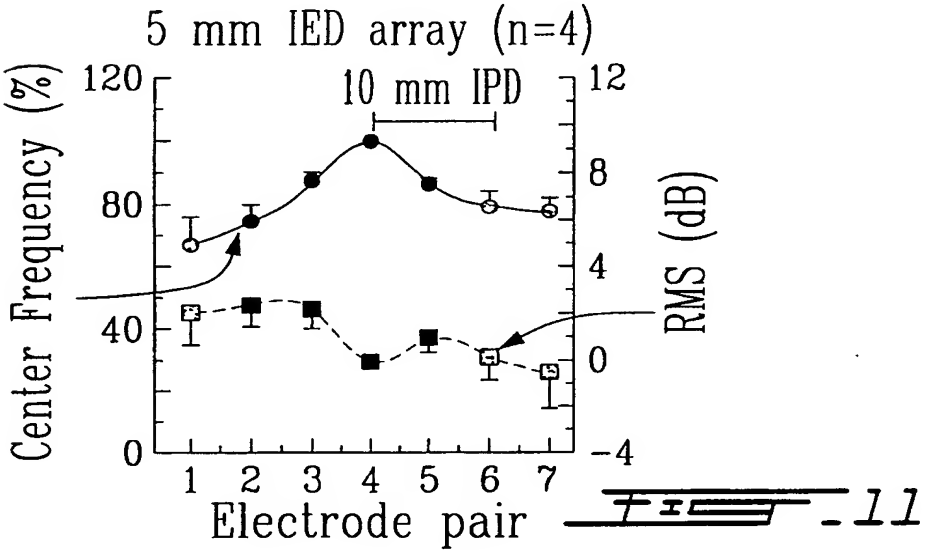

Fig. 11

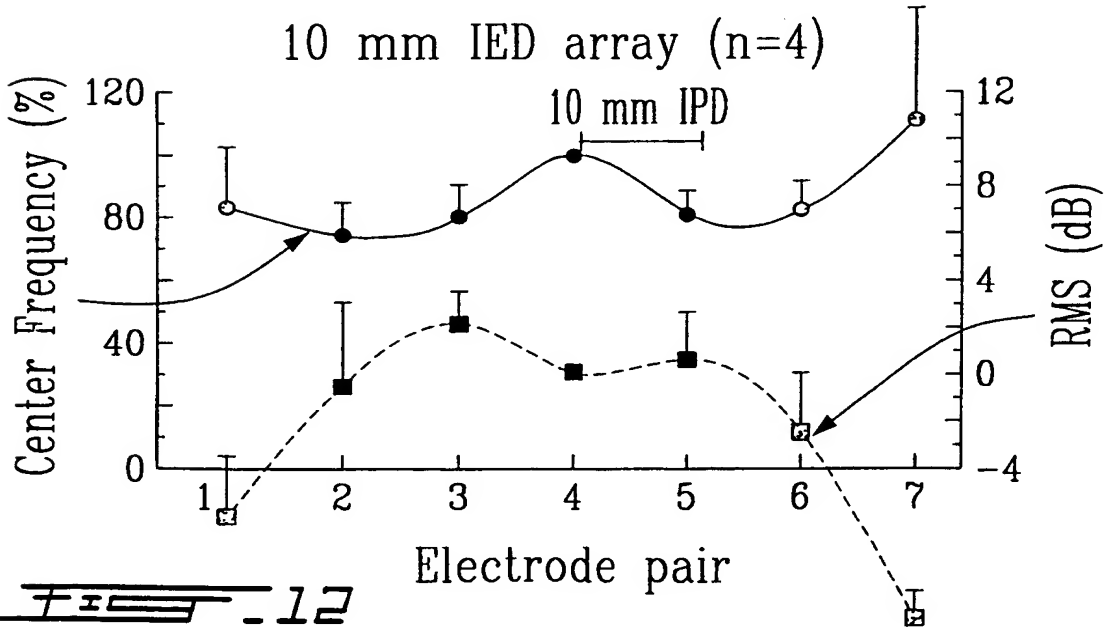

Fig. 12

INTERNATIONAL SEARCH REPORT

Internati[illegible]lication No
PCT/CA 00/00808

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B5/0488 A61B5/0492

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61B G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, INSPEC, BIOSIS, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	TADASHI MASUDA ET AL: "the position of innervation zones in the biceps brachii investigated by surface electromyography" IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, vol. BME-32, no. 1, 1 January 1985 (1985-01-01), pages 36-42, XP002153958 New York, US page 36, left-hand column, line 1 -page 40, right-hand column, line 28; tables 1-6 ---	1,2,4-8, 10,15, 16, 18-22,24
Y	WO 98 48877 A (GRASSINO ALEJANDRO ;SINDERBY CHRISTER (SE); FRIBERG SVEN (SE); LIN) 5 November 1998 (1998-11-05) page 13, line 19 -page 19, line 14; tables 1-7 --- -/--	1,2,4-8, 10,15, 16, 18-22,24

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
28 November 2000	12/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340-2040, Tx. 31 651 epo nl. Fax: (+31–70) 340-3016	Weihs, J

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 671 752 A (SINDERBY CHRISTER ET AL) 30 September 1997 (1997-09-30) column 2, line 61 -column 5, line 50	1,2,4, 15,16,18
A	HARALD REUCHER ET AL: "spatial filtering of noninvasive emg: part I - introduction to measuring technique and applications" IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, vol. BME-34, no. 2, 1 February 1987 (1987-02-01), pages 98-105, XP002153959 New York, US page 98, column 1, line 1 -page 104, left-hand column, line 2; tables 1-6	1,15

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internati[redacted]cation No
PCT/CA 00/00808

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9848877 A	05-11-1998	US 5820560 A	13-10-1998
		AU 3534497 A	24-11-1998
		EP 0979118 A	16-02-2000
US 5671752 A	30-09-1997	CA 2172329 A	01-10-1996
		US 5820560 A	13-10-1998